Preliminary data on the effect of semi-synthetic baits for Noctuidae (Lepidoptera) on the non-target Lepidoptera species

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SUMMARY

Noctuidae are one of the most important Lepidoptera groups containing dangerous pest species. Monitoring and detection of these pest species is routinely performed by traps baited with sex-pheromones. Baits that attract both males and females were developed for improved pest management. First the effectiveness of different synthetic compounds was evaluated. We also tested semi-synthetic baits that contained both synthetic and natural components (wine and beer). These were more attractive for moths considering species richness and abundance. Disadvantage of this increased effectiveness is that the traps catch more non target, rare and even protected species. In this study we analysed the effect of semi-synthetic baits developed for Noctuid moths containing wine on other non-target Lepidopterans. In the six sampling sites traps caught 17158 individuals of 183 Lepidoptera species. The number of Noctuidae species was 124, while their proportion was 84.4%. The traps caught 813 individuals of 9 protected and 20 valuable species, which was only 4.7% of all Lepidopterans. In contrast the mean proportion of 33 dangerous and potential pest species was 31.3% (5375 individuals). Number and abundance of both protected and pest species were affected by landscape structure. The risks of catching non-target species was higher in species rich natural and semi-natural landscape. In homogenous arable lands the number and proportion of valuable Lepidopterans was not significant.

Keywords: pest monitoring, food attractants, loss of biodiversity, semi-synthetic baits

INTRODUCTION

Noctuidae is one of the most important families of Lepidoptera because of several dangerous and economically important pest species. The monitoring of these pests, which is an important part of the IPM (Integrated Pest Management) strategy against them, is generally performed by different trapping methods. In the last decades, widely used sex pheromone-baited traps have replaced the light traps used before. These baited traps can easily be used and are very effective and species specific, but lure only male moths. However, data of females are more valuable for pest control decisions, so the development of female catching baits have been ongoing since the 1970's (Creighton *et al.*, 1973; Cantelo and Jacobson, 1979; Landolt, 2000; Landolt and Alfaro, 2001; Tóth *et al*., 2010). The effectiveness of several synthetic compounds (e.g. phenylacetaldehyde, isoamyl-alcohol and isobutanol in combination with acetic acid) were proved to be effective for Noctuid moths. The effectiveness of these synthetic baits can be increased with wine and beer as natural additives. These 'semi-synthetic' baits lure more species and more individuals than the synthetic ones (Nagy *et al.*, 2014; Tóth *et al*., 2015). These synthetic and semi-synthetic baits are more general attractants than species specific pheromones. Using these traps, several important pest species can be monitored in the same time minimizing sampling effort (Tóth *et al*., 2010). The remarkable disadvantage of the lack of specificity is the risk of catching non-target and even rare or protected species. In some cases, even the more specific traps baited with sex pheromone can also catch non target species (Olenici *et al*., 2007), but the probability of non-target catches might be much higher in case of traps baited with feeding attractants.

In the present study, the effect of semi-synthetic baits, consisting of isoamyl alcohol, acetic acid and wine, was analysed on the non-pest, non-target Lepidoptera species. We used data from different studies, which aimed to develop 'bisex' (attractive for both males and females) baits or faunistic analysis of natural and semi-natural habitats. Our goal was to determine the amount of the non-target effect and provide a basis for further investigations.

MATERIAL AND METHODS

In the present analysis we used data of different studies on semi-synthetic baits for trapping Noctuid pest species. The sampling was carried out in six locations in East and Northeast Hungary (5 sites) and West Ukraine (1 site) during 2013-2014. Four of the sampling sites (Forró, Balmazújváros, Debrecen-Ondód, Hernádnémeti) were located in mostly agricultural landscape surrounded by intensively used arable lands while the others (Nagycsere and Nagydobrony) were surrounded with more diverse extensively used landscapes (*Figure 1*, *Table 1*).

Figure 1: **Location of the sampling sites and linear transects of the traps in the six studied sites in 2013-2014 (Surce: GoogleEarth).**

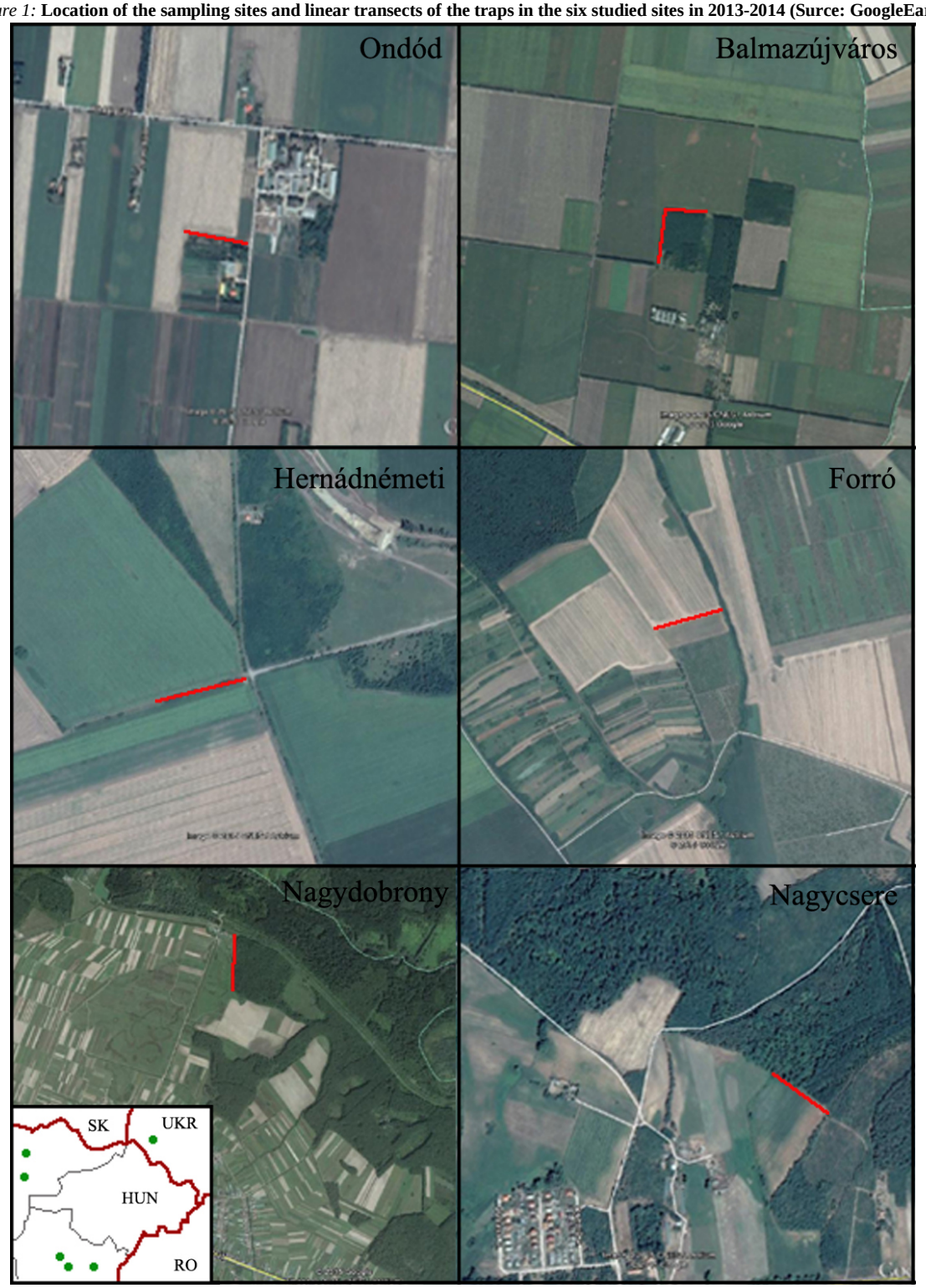

Table 1

GPS coordinates of sites and sampling periods of Noctuid moths in the six sampling sites studied in 2013-2014

Sampling area	N	E	Start	Finish
Forró	47° 19.770'	21° 3.773'	1st July 2013	1st November 2013
Debrecen-Ondód	47° 32.031'	21° 31.053	2nd July 2013	2nd November 2013
Nagydobrony	48° 25.619'	22° 25.128'	20th July 2014	19th October 2014
Nagycsere	47° 31.847'	21° 46.910'	17th July 2014	12th November 2014
Hernádnémeti	48° 9.595'	21° 2.991'	2nd July 2014	16th November 2014
Balmazújváros	47° 36.202'	21° 26.352'	8th July 2014	22nd November 2014

In Forró, Ondód, Hernádnémeti and Balmazújváros the effect of natural compounds (wine and beer) and their extracts on the efficiency of synthetic lures was tested. In Nagycsere the Noctuidae fauna of a semi-natural landscape, while in Nagydobrony the fauna of the protected Nagydobrony Game Reserve was studied using synthetic and semi-synthetic baits for Noctuid species. We use the data collected by semi-synthetic baits contain mixture of isoamyl alcohol, acetic acid and red wine (1:1:1, 3 ml), which was used in all of the six studies. Polypropylene tubes with 4 ml capacity were used as dispensers (Tóth *et al*., 2015). The mixture was administered on dental rolls inside the tubes. The lure could evaporate across a small opening with 4 mm in diameter, which was opened when setting out in the field. The trapped moths were killed by an insecticide strip.

During the studies CSALOMON® VarL+ traps were used in five (Balmazújváros, Ondód, Hernádnémeti and Forró) or four (Nagydobrony, Nagycsere) repetitions. The traps were placed in the sites on trees situated in the edge of the sites in 1.8-2 m height. The distance between the traps was 40-100 m depending on the design of the given study. The samplings were mostly carried out between July and November in 2013 and 2014 (*Table 1*). The traps were emptied twice a week (Forró, Ondód, Balmazújváros and Hernádnémeti) or weekly (in the faunistic studies in Nagycsere and Nagydobrony). The baits were changed in every four weeks. The collected material was deep-frozen and stored until identification. The sampled individuals were identified according the works of Kádár *et al*. (2010), Mészáros and Szabóky (2012) and Varga (2011). For the nomenclature and characterization of species, the book „Magyarország Nagylepkéi" (Varga, 2011) were used.

For characterization of the sampled material total number of species and individuals, number of species and individuals per site and their means per trap was used. These variables were also tallied by families especially for Noctuidae. In order to characterize and assess the effect of the semi-synthetic baits on non-target Lepidoptera species the groups of pest and vulnerable (protected and/or faunistically interesting) species were also characterized with total and mean number of species and individuals in case of groups, families and species. The conservation value of the species was established on the basis of KÖM (2001). The group of pest species was established on the basis of Jermy and Balázs 1993, Szabóky and Leskó (1999) and Tóth (1999).

RESULTS AND DISCUSSION

In the six sampling sites the traps caught 17642 Lepidoptera that belonged to 184 species and nine families (see Appendix 1). The 2.7 % (n=484) of the specimens could be identified only at the family level. In case of Hepialidae only one specimen was caught that also could not be identified at species level (*Table 2*). Beyond that 843 individuals of Vespidae species (*Vespa crabro*, *V. germanica* and *Polistes* sp.) and 11 honey-bees (*Apis mellifera*) were sampled.

The most species rich sites were Nagycsere (128) and Nagydobrony (91), which can be characterised by most diverse landscape structure than the others, where the species number ranged between 57 and 70. The mean number of species per trap was higher in Nagycsere (71.3±7.1) while in Ondód a trap lured only 33.2 (±5.5) species on the average. The abundance of Lepidoptera generally was higher in the less diverse arable lands. The mean number of individuals per trap was the highest in Balmazújváros (1162±127.1), however the abundance was relatively high also in the species rich Nagycsere (640.8±95.3) (*Table 2*).

The semi-synthetic bait used in these samplings was developed to monitor noctuid pest species. In the six sites 126 Noctuidae species of 17 subfamilies were sampled, which were 68.9% of all sampled Lepidoptera. The ratio of Noctuidae species among all sampled Lepidoptera was higher (82.9-90.6%) in the less diverse agro-ecosystems than in the most diverse extensively used landscapes (67.2-72.5%). The total number of Noctuid moths was 14487 that was the 84.4% of the identified Lepidopterans and their ratio varied between 70.2-95.5 by sites. The baits showed much higher effectiveness in case of species belonging to Xyleninae, Noctuinae, Hadeninae and Acronictinae subfamilies, which cumulative ratio was 80.4% (11653 individuals) among sampled Noctuidae moths (*Table 2*).

Table 2

The characteristic variables of samples taken in the six studied sites in 2013-2014. N: number of individuals, Ntrap: mean number of individuals per trap [individuals/trap], S: number of species, Strap: mean number of species by trap [species/trap], SD: standard deviation

	Forró			Ondód			Hernádnémeti			Balmazújváros		
Number of individuals	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD
Hepialidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Pyralidae	77	15.4	9.2	245	49.0	24.7	756	151.2	31.8	124	24.8	8.3
Nymphalidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Sphingidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Geometridae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Thyatiridae	0	0.0	0.0	2	0.4	0.9	33	6.6	4.2	370	74.0	20.6
Nolidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Erebidae	53	10.6	4.4	37	7.4	2.4	104	20.8	15.0	19	3.8	2.2
Noctuidae	2791	558.2	137.6	646	129.2	35.2	2458	491.6	52.2	5297	1059.4	122.7
Xyleninae	991	198.2	50.4	363	72.6	23.9	896	179.2	23.8	3287	657.4	70.4
Noctuinae	103	20.6	4.3	43	8.6	3.8	429	85.8	12.1	1262	252.4	47.7
Hadeninae	912	182.4	48.6	72	14.4	1.8	563	112.6	23.3	191	38.2	5.7
Other Noctuidae subfam.	537	107.4	23.0	94	18.8	13.0	447	89.4	19.5	421	84.2	19.5
non identified Lepidoptera*	140	28.0	14.7	12	2.4	2.2	2	0.4	0.5	0	0.0	0.0
identified Lepidoptera	2921	584.2	140.9	930	186.0	58.8	3351	670.2	61.3	5810	1162.0	127.1
Numberof species	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD
Lepidoptera species number	64	48.4	3.4	59	33.2	5.4	70	57.6	2.2	57	44.6	3.4
Hepialidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Pyralidae	2	1.2	0.4	3	2.2	0.4	3	2.8	0.4	3	2.8	0.4
Nymphalidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Sphingidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Geometridae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Thyatiridae	0	0.0	0.0	1	0.2	0.4	3	1.8	0.4	3	1.8	0.8
Nolidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Erebidae	4	3.2	0.4	6	3.0	1.2	6	4.2	1.3	3	1.6	0.5
Noctuidae	58	44.0	3.4	49	27.8	4.5	58	48.8	1.8	48	38.4	3.2
Xyleninae	28	19.0	3.1	24	14.2	2.9	27	21.6	1.1	25	20.0	1.4
Noctuinae	8	7.2	0.4	8	5.0	1.0	10	10.0	0.0	10	7.8	1.1
Hadeninae	11	10.4	0.9	9	4.4	0.9	12	9.6	0.5	8	6.2	1.1
Other Noctuidae subfam.	11	7.4	1.1	8	4.2	0.4	9	7.6	1.5	5	4.4	0.9

	Nagydobrony			Nagycsere			Total		
Number of individuals	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD
Hepialidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Pyralidae	0	0.0	0.0	0	0.0	0.0	1202	42.93	56.46
Nymphalidae	7	1.8	1.0	7	1.8	1.0	14	0.50	0.92
Sphingidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Geometridae	12	3.0	2.2	68	17.0	9.9	80	2.86	6.87
Thyatiridae	121	30.3	17.4	207	51.8	21.5	733	26.18	31.53
Nolidae	0	0.0	0.0	2	0.5	1.0	2	0.07	0.38
Erebidae	330	82.5	13.3	96	24.0	13.0	639	22.82	27.26
Noctuidae	1112	278.0	47.9	2183	545.8	108.7	14487	517.39	313.91
Xyleninae	477	119.3	13.8	1298	324.5	123.7	7312	261.14	210.27
Noctuinae	72	18.0	4.4	471	117.8	78.2	2380	85.00	94.38
Hadeninae	85	21.3	9.3	138	34.5	22.6	1961	70.04	66.91
Other Noctuidae subfam.	421	105.25	32.88	169	42.25	6.18	2089	74.61	38.31
non identified Lepidoptera*	93	23.3	6.6	237	59.3	28.9	484	17.29	23.81
identified Lepidoptera	1583	395.8	62.8	2563	640.8	95.3	17158	612.79	324.49
Numberof species	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD
Lepidoptera species number	91	57.0	5.4	128	71.3	7.1	183	51.14	12.61
Hepialidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Pyralidae	0	0.0	0.0	0	0.0	0.0	3	1.61	1.23
Nymphalidae	4	1.5	1.0	3	1.5	0.6	5	0.43	0.79
Sphingidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Geometridae	4	1.8	0.5	12	4.5	1.3	15	0.89	1.69
Thyatiridae	3	3.0	0.0	4	3.3	0.5	4	1.57	1.32
Nolidae	0	0.0	0.0	2	0.5	1.0	2	0.07	0.38
Erebidae	13	8.5	1.9	21	8.8	3.3	27	4.61	3.08
Noctuidae	66	42.0	3.2	86	52.8	3.8	126	41.93	8.70
Xyleninae	36	22.8	1.5	45	27.8	3.2	63	20.57	4.59
Noctuinae	12	8.5	0.6	17	11.0	1.2	20	8.14	2.10
Hadeninae	7	4.3	1.0	7	5.5	1.3	15	6.86	2.63
Other Noctuidae subfam.	11	6.5	1.3	17	8.5	1.0	28	6.36	1.93

*Individuals identified only in family level.

In Forró all the five most abundant species, in Ondód, Hernádnémeti and Balmazújváros four, while Nagycsere and Nagydobrony three of them were Noctuid moths. Beyond them the baits lured high number of *Hypsopygia costalis* (Pyralidae), *Pelosia muscerda* (Erebidae) and two Thyatiridae species (*Tethea ocularis* and *Thyatria batis*). The most abundant species of the sites are mostly occurred in all sites, but the locally dominant

Pelosia muscerda, *Cirrhia icterica* and *Craniophora ligustri* occurred only in two sites with higher habitat diversity (Nagycsere and Nagydobrony). The common and polyphagous *Agrochola circellaris*, *Mythimna albipuncta*, *Xestia xanthographa* and *Acronicta rumicis* were dominant in three sites. The also widely distributed *Cirrhia ocellaris*, *Hypsopygia costalis*, *Allophyes oxyacanthae*, *Trachea atriplicis*, *Tethea ocularis* and *Agrotis segetum* reached high relative frequencies in two whereas the others only in one site (*Table 3*). Most of these species feed on tree canopy and only 6 of them can be regarded as real or potential pest species. Among them only *Agrotis segetum*, which can cause significant damage in most crops and even in horticulture, is a harmful pest.

Table 3

Five most abundant species of the studied sites with their relative frequencies [RF%] and number of occupied sites. The species are ordered decreasingly by their summarised RF%

	Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum	site (n=6)
Cirrhia ocellaris				30.31		7.062	11.70	6
Xestia xanthographa			5.222	19.21		11.51	9.58	6
*Agrochola circellaris**		19.46	4.775	11.93			7.06	6
*Hypsopygia costalis**		24.84	20.53				6.06	4
Allophyes oxyacanthae	10.58				17.62		4.59	6
Trachea atriplicis	13.45				12.57		4.14	6
Mythimna albipuncta	12.26	4.731	5.103				3.99	6
*Acronicta rumicis**	5.067	6.882	6.625				3.22	6
Tethea ocularis				6.299		4.955	2.88	3
*Agrotis segetum**	5.923	5.269					2.80	6
*Acronicta megacephala**				5.146			1.89	6
Pelosia muscerda					16.36		1.68	2
Agrochola helvola						6.087	1.29	5
Cirrhia icteritia						4.487	0.80	2
*Thyatira batis**					5.559		0.74	4
Craniophora ligustri					3.348		0.31	2

* pest species

The number of harmful and potentially significant pest species was 32 in the samples. Most of them (20) belong to the Noctuidae family and there were 5 Erebidae, 2 Geometridae, 3 Pyralidae and 2 Thyatiridae species. The mean number of pest species per trap was lower in Debrecen-Ondód (12.0±2.0) while this value reached the maximum in Hernádnémeti (17.6±1.1). The total number of pests was 5373 which was 31.3% of all Lepidoptera samples. The ratio of the pest species was higher in the agricultural sites then in the most diverse ones. The mean proportion of Noctuidea was 74.6(±18.2)% and the Pyralidae was 18.1(±19.1)% while the other three family played a minor role. Baits lured the most individuals of *Hypsopygia costalis*, *Agrochola circellaris*, *Acronicta rumicis*, *Agrotis segetum* and *Noctua pronuba*. Most of them occurred at all of the studied sites, but the *Hypsophygia costalis* was caught only the agricultural sites. In Balmazújváros high abundance of *Agrochola circellaris* and *Acronicta megacephala* was caused by nearby poplar plantation. These plantations can be a source of these pests. Considerable part of the pest species could be found with low abundance and 8 of them occurred only in the two more diverse species rich sites (*Table 4*).

The traps caught 34 individuals of seven protected Noctuidae, one Erebidae and one Nymphalidae species in all of the six sampling sites. Six of them and 19 other species are interesting and valuable in faunistical aspect. They mostly belong to the Noctuidae family however there were two Erebidae and two Geometridae species. During the studies totally 411 individuals of these valuable species were sampled, which is 2.4% of the Lepidopteans identified at species level while the ratio of the protected Lepidopterans was only 0.2%. In Balmazújváros protected species were not sampled and only one valuable species could be found, however the number of protected species was also low both in the species rich Nagycsere and Nagydobrony. The number of faunistically interesting and protected species was much lower in the agricultural sites (max. 7 species) than in the two semi natural ones (14 and 15 species). The number of valuable species was the highest in Nagycsere where 4 protected and 11 faunistically interesting species were trapped. The ratio of valuable individuals differed between 2.9-4.5% by sites, but the ratio of protected species was lower than 1% in each site (*Table 5*).

Table 4

List of the pest species caught in the six sampling sites in 2013-2014 with their number of individuals and ratio among all Sampled Lepidoptera and taxonomy. Species are arranged by decreasing number of individuals

Family		Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum
Noctuidae	*Agrochola circellaris*	61	181	160	693	12	104	1211
Pyralidae	*Hypsopygia costalis*	76	231	688	44	0	0	1039
Noctuidae	*Acronicta rumicis*	148	64	222	68	16	34	552
Noctuidae	*Agrotis segetum*	173	49	88	99	25	46	480
Noctuidae	*Noctua pronuba*	29	29	102	95	17	103	375
Noctuidae	*Acronicta megacephala*	1	2	9	299	3	11	325
Noctuidae	*Lacanobia oleracea*	70	7	69	17	21	13	197
Noctuidae	*Agrotis exclamationis*	40	1	10	1	32	48	132
Noctuidae	*Xestia c-nigrum*	38	1	53	23	11	3	129
Thyatiridae	*Thyatira batis*	0	0	20	2	88	17	127
Pyralidae	*Ostrinia nubilalis*	0	3	50	71	0	0	124
Noctuidae	*Agrotis ipsilon*	26	24	25	36	0	11	122
Noctuidae	*Conistra vaccinii*	14	0	2	8	12	68	104
Noctuidae	*Phlogophora meticulosa*	11	4	48	16	7	13	99
Noctuidae	*Lacanobia suasa*	81	1	4	0	1	3	90
Noctuidae	*Mamestra brassicae*	38	7	28	6	0	0	79
Pyralidae	*Pyralis farinalis*	1	11	18	9	0	0	39
Thyatiridae	*Habrosyne pyrithoides*	0	2	12	2	14	1	31
Noctuidae	*Hadula trifolii*	9	1	13	1	0	0	24
Noctuidae	*Helicoverpa armigera*	0	0	0	0	1	22	23
Noctuidae	*Acronicta psi*	9	8	2	0	0	0	19
Erebidae	*Euclidia glyphica*	15	1	0	0	0	0	16
Noctuidae	*Cosmia trapezina*	4	1	0	0	5	4	14
Erebidae	*Scoliopteryx libatrix*	0	1	0	0	11	0	12
Erebidae	*Phragmatobia fuliginosa*	0	0	0	0	0	3	3
Erebidae	*Lymantria dispar*	0	0	0	0	0	1	1
Erebidae	*Lymantria monacha*	0	0	0	0	0	1	1
Geometridae	*Ectropis crepuscularia*	0	0	0	0	0	1	1
Geometridae	*Peribatodes rhomboidaria*	0	0	0	0	0	1	1
Noctuidae	*Colocasia coryli*	0	0	0	0	0	1	1
Noctuidae	*Autographa gamma*	0	0	0	0	0	1	1
Noctuidae	*Macdunnoughia confusa*	0	0	0	0	0	1	1
Total number of pests		844	629	1623	1490	276	511	5373
Ratio of pests among all Lepidoptera (%)		28.9	67.6	48.4	25.6	17.5	20.0	31.3
Total number of identified Lepidoptera		2921	930	3351	5810	1583	2563	17158

Semi-synthetic baits used in this study attract a large amount of Noctuid moths. Both the species number and abundance were high in each sampling sites, although they depend on the landscape structure. High landscape diversity results in higher species richness but in case of abundance it does not cause differences. The bait also lured Vespidae species with relatively high abundance, but did not attract honey-bees. Most of the sampled Lepidopterans belonged to the Noctuidae family (totally 124 species). Among them the species of Noctuidne, Xyleninae and Hadeninae subfamilies were the most abundant. Beyond them the species number of Erebidae and Geometridae families was the highest. Among the most abundant species there were six pests: *Agrochola circellaris*, *Hypsopygia costalis*, *Acronicta rumicis*, *Agrotis segetum*, *Acronicta megacephala* and *Thyatiria batis*. The dominant species of arable land and more diverse sites were different. The total number of pest species was 32. Most of them (20) were noctuid moths containing such harmful ones as *Agrotis segetum*, *Agrotis exclamationis*, *Agrotis ipsilon*, *Lacanobia oleracea* etc.. The summarised proportion of these species was 31.3% among all identified Lepidopterans. Considering their economic importance the majority of the caught Lepidopterans were indifferent. Both number and abundance of protected and valuable species was low, however the risk of catching valuable and non-target species was higher in the natural and semi natural sites. The traps caught totally 411 individuals of 28 protected and/or faunistically interesting species, which was a very little part (2.4%) of all sampled Lepidopterans.

On the basis of these preliminary results the use of the tested semi-synthetic bait does not endanger the populations of non-target Lepidopterans. For more detailed results we should carry out further studies and should analyse these and other ongoing studies together.

Table 5

List of the protected and faunistically interesting species caught in the six sampling sites in 2013-2014 with their number of individuals and ratio among all sampled Lepidoptera and taxonomy. P: protected, F: faunistically interesting

Prot.	Family		Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum
P/F	Noctuidae	*Meganephria bimaculosa*	2	0	0	0	0	0	2
P/F	Noctuidae	*Enargia paleacea*	0	0	0	0	1	5	6
P/F	Noctuidae	*Lithophane semibrunnea*	0	1	1	0	2	0	4
P/F	Noctuidae	*Mormo maura*	0	0	0	0	3	0	3
P/F	Noctuidae	*Orbona fragariae*	4	0	0	0	0	1	5
P/F	Noctuidae	*Staurophora celsia*	0	0	0	0	0	9	9
P	Erebidae	*Catocala fraxini*	0	0	0	0	1	1	2
P	Noctuidae	*Catephia alchymista*	0	1	0	0	0	0	1
P	Nymphalidae	*Apatura ilia*	0	0	0	0	2	0	2
F	Erebidae	*Catocala hymenaea*	0	1	75	0	0	0	76
F	Erebidae	*Herminia tenuialis*	0	0	0	0	0	1	1
F	Geometridae	*Euphya unangulata*	0	0	0	0	2	0	2
F	Geometridae	*Idaea muricata*	0	0	0	0	0	14	14
F	Noctuidae	*Eucarta amethystina*	0	0	0	0	2	0	2
F	Noctuidae	*Eucarta virgo*	22	0	0	0	14	1	37
F	Noctuidae	*Diarsia rubi*	0	0	0	0	0	5	5
F	Noctuidae	*Euxoa segnilis*	0	0	0	0	2	7	9
F	Noctuidae	*Xestia castanea*	0	0	0	0	2	0	2
F	Noctuidae	*Xestia sexstrigata*	0	0	0	0	2	2	4
F	Noctuidae	*Agrochola humilis*	3	3	2	0	0	8	16
F	Noctuidae	*Agrochola laevis*	3	9	2	0	0	34	48
F	Noctuidae	*Agrochola lota*	0	0	1	0	33	0	34
F	Noctuidae	*Atethmia centrago*	0	0	0	0	4	0	4
F	Noctuidae	*Blepharita satura*	0	0	0	0	0	1	1
F	Noctuidae	*Dryobotodes eremita*	45	7	14	0	0	0	66
F	Noctuidae	*Helotropha leucostigma*	0	0	0	0	0	1	1
F	Noctuidae	*Tiliacea citrago*	0	0	0	0	1	0	1
F	Noctuidae	*Xylena exsoleta*	5	3	20	14	0	12	54
Number of valuable species			7	7	7	1	14	15	28
Number of protected species			2	2	1	0	5	4	9
Number of valuable individuals			84	25	115	14	71	102	411
Number of protected individuals			6	2	1	0	9	16	34
Ratio of valuable individuals			2.88	2.69	3.43	0.24	4.49	3.98	2.40
Ratio of protected individuals			0.21	0.22	0.03	0.00	0.57	0.62	0.20
Total number of identified Lepidoptera			2921	930	3351	5810	1583	2563	17158

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Appendix 1

List of the sampled Lepidoptera species with their taxonoamy and conservational status. Pest species are signed with asterix (*). P: protescted, F: faunistically interesting

		Family	Subfamily	Species
		Hepialidae		*one unidentified species*
	*	Pyralidae	Pyralinae	*Hypsopygia costalis* (Fabricius 1775)
	*	Pyralidae	Pyralinae	*Pyralis farinalis* (Linnaeus, 1758)
	*	Pyralidae	Pyraustinae	*Ostrinia nubilalis* (Hübner, 1796)
P		Nymphalidae	Apaturinae	*Apatura ilia* ([Denis & Schiff ermüller], 1775)
		Nymphalidae	Nymphalinae	*Araschnia levana* (Linnaeus, 1758)
		Nymphalidae	Nymphalinae	*Nymphalis c-album* (Linnaeus, 1758)
		Nymphalidae	Satyrinae	*Minois dryas* (Scopoli, 1763)
		Nymphalidae	Satyrinae	*Pararge aegeria tircis* (Godart, 1821)
		Sphingidae	Macroglossinae	*Deilephila porcellus* (Linnaeus, 1758)
		Geometridae	Ennominae	*Apeira syringaria* (Linnaeus, 1758)
		Geometridae	Ennominae	*Cabera exanthemata* (Scopoli, 1763)
	*	Geometridae	Ennominae	*Ectropis crepuscularia* ([Denis et Schiffermüller], 1775)
		Geometridae	Ennominae	*Ematurga atomaria* (Linnaeus, 1758)
		Geometridae	Ennominae	*Hypomecis punctinalis* (Scopoli, 1763)
		Geometridae	Ennominae	*Hypomecis roboraria* ([Denis & Schiffermüller], 1775)
		Geometridae	Ennominae	*Ligdia adustata ([Denis & Schiffermüller], 1775)*
		Geometridae	Ennominae	*Macaria notata* (Linnaeus, 1758)
	*	Geometridae	Ennominae	*Peribatodes rhomboidaria* ([Denis & Schiffermüller], 1775)
		Geometridae	Larentiinae	*Cosmorhoe ocellata* (Linnaeus, 1758)
		Geometridae	Larentiinae	*Epirrita autumnata* (Borkhausen, 1794)
F		Geometridae	Larentiinae	*Euphya unangulata* (Haworth, 1809)
		Geometridae	Sterrhinae	*Idaea aversata* (Linnaeus, 1758)
F		Geometridae	Sterrhinae	*Idaea muricata* (Hufnagel, 1787)
		Geometridae	Sterrhinae	*Timandra comae* (Schmidt, 1931)
	*	Thyatiridae	Thyatirinae	*Habrosyne pyrithoides* (Hufnagel, 1766)
		Thyatiridae	Thyatirinae	*Tethea ocularis* (Linnaeus, 1758)
		Thyatiridae	Thyatirinae	*Tethea or* ([Denis et Schiffermüller], 1775)
	*	Thyatiridae	Thyatirinae	*Thyatira batis* (Linnaeus, 1758)
		Nolidae	Nolinae	*Nola cristatula (Hübner, 1793)*
		Nolidae	Nolinae	*Nycteola degenerana* (Hübner, 1799)
	*	Erebidae	Arctiinae	*Phragmatobia fuliginosa* (Linnaeus, 1758)
		Erebidae	Aventiinae	*Trisateles emortualis* ([Denis & Schiff ermüller], 1775)
	*	Erebidae	Calpinae	*Scoliopteryx libatrix* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala electa* (Vieweg, 1790)
		Erebidae	Catocalinae	*Catocala elocata* (Esper, 1788)
P		Erebidae	Catocalinae	*Catocala fraxini* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala fulminea* (Scopoli, 1763)
F		Erebidae	Catocalinae	*Catocala hymenaea* ([Denis & Schiff ermüller], 1775)
		Erebidae	Catocalinae	*Catocala nupta* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala promissa* (Denis & Schiffermüller, 1775)
		Erebidae	Catocalinae	*Catocala sponsa* (Linnaeus, 1767)
		Erebidae	Catocalinae	*Dysgonia algira* (Linnaeus, 1767)
	*	Erebidae	Catocalinae	*Euclidia glyphica* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Lygephila craccae* ([Denis & Schiff ermüller], 1775)
		Erebidae	Catocalinae	*Lygephila pastinum* (Treitschke, 1826)
		Erebidae	Eustrotiinae	*Protodeltote pygarga* (Hufnagel, 1766)
		Erebidae	Herminiinae	*Herminia grisealis* ([Denis & Schiff ermüller], 1775)
		Erebidae	Herminiinae	*Herminia tarsipennalis* (Treitschke, 1835)
F		Erebidae	Herminiinae	*Herminia tenuialis* (Rebel,1899)
		Erebidae	Hypeninae	*Hypena proboscidalis* (Linnaeus, 1758)
		Erebidae	Hypeninae	*Hypena rostralis* (Linnaeus, 1758)
		Erebidae	Lithosiinae	*Eilema griseola* (Hübner, 1803)
		Erebidae	Lithosiinae	*Lithosia quadra* (Linnaeus, 1758)
		Erebidae	Lithosiinae	*Pelosia muscerda* (Hufnagel, 1766)
		Erebidae	Lithosiinae	*Wittia sororcula* (Hufnagel, 1766)
	*	Erebidae	Lymantriinae	*Lymantria dispar* Linnaeus, 1758
	*	Erebidae	Lymantriinae	*Lymantria monacha* (Linnaeus, 1758)

Continuation of Appendix 1.

		Family	Subfamily	Species
		Noctuidae	Acontiinae	*Aedia leucomelas* (Linnaeus, 1758)
		Noctuidae	Acronictinae	*Acronicta auricoma* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Acronictinae	*Acronicta euphorbiae* ([Denis & Schiff ermüller], 1775)
	*	Noctuidae	Acronictinae	*Acronicta megacephala* ([Denis & Schiff ermüller], 1775)
	*	Noctuidae	Acronictinae	*Acronicta psi* (Linnaeus, 1758)
	*	Noctuidae	Acronictinae	*Acronicta rumicis* (Linnaeus, 1758)
		Noctuidae	Acronictinae	*Craniophora ligustri* ([Denis & Schiffermüller], 1775)
		Noctuidae	Acronictinae	*Moma alpium* (Osbeck, 1778)
		Noctuidae	Amphipyrinae	*Amphipyra berbera svenssoni* (Fletcher, 1968)
		Noctuidae	Amphipyrinae	*Amphipyra livida* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Amphipyrinae	*Amphipyra pyramidea* (Linnaeus, 1758)
		Noctuidae	Amphipyrinae	*Amphipyra tragopoginis* (Clerck, 1759)
		Noctuidae	Bryophilinae	*Cryphia algae* (Fabricius, 1775)
P		Noctuidae	Catocalinae	*Catephia alchymista* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Condicinae	*Eucarta amethystina* (Hübner, 1803)
F		Noctuidae	Condicinae	*Eucarta virgo* (Treitschke, 1825)
		Noctuidae	Cryphiinae	*Globia algae* (Esper, 1789)
		Noctuidae	Ctenuchinae	*Amata phegea* (Linnaeus, 1758)
		Noctuidae	Hadeninae	*Hada plebeja* (Linnaeus, 1761)
	*	Noctuidae	Hadeninae	*Hadula trifolii* (Hufnagel, 1766)
		Noctuidae	Hadeninae	*Lacanobia contigua* ([Denis & Schiff ermüller], 1775)
	*	Noctuidae	Hadeninae	*Lacanobia oleracea* (Linnaeus, 1758)
	*	Noctuidae	Hadeninae	*Lacanobia suasa* ([Denis & Schiffermüller], 1775)
		Noctuidae	Hadeninae	*Lacanobia thalassina* (Hufnagel, 1766)
		Noctuidae	Hadeninae	*Lacanobia w-latinum* (Hufnagel, 1766)
		Noctuidae	Hadeninae	*Leucania obsoleta* (Hübner 1803)
	*	Noctuidae	Hadeninae	*Mamestra brassicae* (Linnaeus, 1758)
		Noctuidae	Hadeninae	*Mythimna (Mythimna) pallens* (Linnaeus, 1758)
		Noctuidae	Hadeninae	*Mythimna albipuncta* ([Denis et Schiffermüller], 1775)
		Noctuidae	Hadeninae	*Mythimna ferrago* (Fabricius, 1787)
		Noctuidae	Hadeninae	*Mythimna l-album* (Linnaeus, 1767)
		Noctuidae	Hadeninae	*Mythimna turca* (Linnaeus, 1761)
		Noctuidae	Hadeninae	*Mythimna vitellina* (Hübner, 1808)
		Noctuidae	Hadeninae	*Tholera cespitis* ([Denis & Schiffermüller], 1775)
	*	Noctuidae	Heliothinae	*Helicoverpa armigera* (Hübner, 1808)
		Noctuidae	Heliothinae	*Pyrrhia umbra* (Hufnagel, 1766)
	*	Noctuidae	Noctuinae	*Agrotis exclamationis* (Linnaeus, 1758)
	*	Noctuidae	Noctuinae	*Agrotis ipsilon* (Hufnagel, 1766)
	*	Noctuidae	Noctuinae	*Agrotis segetum* ([Denis et Schiffermüller], 1775)
		Noctuidae	Noctuinae	*Axylia putris* (Linnaeus, 1761)
F		Noctuidae	Noctuinae	*Diarsia rubi* (Vieweg, 1790)
F		Noctuidae	Noctuinae	*Euxoa segnilis (*Duponchel, 1837)
		Noctuidae	Noctuinae	*Metagnorisma depuncta* (Linnaeus, 1761)
		Noctuidae	Noctuinae	*Noctua fimbriata* (Schreber, 1759)
		Noctuidae	Noctuinae	*Noctua interjecta* Hübner, 1803
		Noctuidae	Noctuinae	*Noctua interposita* (Hübner, 1790)
		Noctuidae	Noctuinae	*Noctua janthe* (Borkhausen, 1792)
		Noctuidae	Noctuinae	*Noctua janthina* ([Denis & Schiffermüller], 1775)
		Noctuidae	Noctuinae	*Noctua orbona* (Hufnagel, 1766)
	*	Noctuidae	Noctuinae	*Noctua pronuba* (Linnaeus, 1758)
		Noctuidae	Noctuinae	*Ochropleura plecta* (Linnaeus, 1761)
		Noctuidae	Noctuinae	*Xestia baja* ([Denis & Schiffermüller], 1775)
F		Noctuidae	Noctuinae	*Xestia castanea* (Esper, 1798)
	*	Noctuidae	Noctuinae	*Xestia c-nigrum* (Linnaeus, 1758)
F		Noctuidae	Noctuinae	*Xestia sexstrigata* (Haworth, 1809)
		Noctuidae	Noctuinae	*Xestia xanthographa* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Oncocnemidinae	*Calophasia lunula* (Hufnagel, 1766)
	*	Noctuidae	Pantheinae	*Colocasia coryli* (Linnaeus, 1758)
	*	Noctuidae	Plusiinae	*Autographa gamma* (Linnaeus, 1758)
	*	Noctuidae	Plusiinae	*Macdunnoughia confusa* (Stephens, 1850)
		Noctuidae	Psaphidinae	*Allophyes oxyacanthae* (Linnaeus, 1758)
P/F		Noctuidae	Psaphidinae	*Meganephria bimaculosa* (Linnaeus, 1767)
		Noctuidae	Rivulinae	*Rivula sericealis* (Scopoli, 1763)
		Noctuidae	Xyleninae	*Actinotia polyodon* (Clerck, 1759)
	*	Noctuidae	Xyleninae	*Agrochola circellaris* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Agrochola helvola* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Agrochola humilis* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Xyleninae	*Agrochola laevis* (Hübner, 1803)
		Noctuidae	Xyleninae	*Agrochola litura* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Agrochola lota* (Clerck, 1759)
		Noctuidae	Xyleninae	*Agrochola lychnidis* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Agrochola macilenta* (Hübner, 1803)
		Noctuidae	Xyleninae	*Agrochola nitida* ([Denis et Schiffermüller], 1775)

Continuation of Appendix 1.

		Family	Subfamily	Species
		Noctuidae	Xyleninae	*Ammoconia caecimacula* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Apamea anceps* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Apamea lithoxylaea* ([Denis & Schiffermüller], 1775)
		Noctuidae	Xyleninae	*Apamea monoglypha* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Aporophyla lutulenta* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Xyleninae	*Atethmia centrago* (Haworth, 1809)
		Noctuidae	Xyleninae	*Athetis furvula* (Hübner, 1808)
		Noctuidae	Xyleninae	*Athetis gluteosa* (Treitschke, 1835)
F		Noctuidae	Xyleninae	*Blepharita satura* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Xyleninae	*Brachylomia viminalis* (Fabricius, 1777)
		Noctuidae	Xyleninae	*Caradrina clavipalpis* (Scopoli, 1763)
		Noctuidae	Xyleninae	*Caradrina kadenii* Freyer, 1836
		Noctuidae	Xyleninae	*Caradrina morpheus* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Cirrhia gilvago* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Cirrhia icteritia* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Cirrhia ocellaris* (Borkhausen, 1792)
		Noctuidae	Xyleninae	*Conistra erythrocephala* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Conistra ligula* (Esper, 1791)
		Noctuidae	Xyleninae	*Conistra rubiginosa* (Scopoli, 1763)
	*	Noctuidae	Xyleninae	*Conistra vaccinii* (Linnaeus, 1761)
		Noctuidae	Xyleninae	*Conistra veronicae* (Hübner, 1813)
		Noctuidae	Xyleninae	*Cosmia affinis* (Linnaeus, 1767)
	*	Noctuidae	Xyleninae	*Cosmia trapezina* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Dryobotodes eremita* (Fabricius, 1775)
		Noctuidae	Xyleninae	*Dypterygia scabriuscula* (Linnaeus, 1758)
P/F		Noctuidae	Xyleninae	*Enargia paleacea* (Esper, 1788)
		Noctuidae	Xyleninae	*Euplexia lucipara* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Eupsilia transversa* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Griposia aprilina* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Helotropha leucostigma* (Hübner, [1808])
		Noctuidae	Xyleninae	*Hoplodrina ambigua* ([Denis & Schiffermüller, 1775])
		Noctuidae	Xyleninae	*Hoplodrina blanda* ([Denis & Schiffermüller, 1775])
		Noctuidae	Xyleninae	*Lithophane ornithopus* (Hufnagel, 1766)
P/F		Noctuidae	Xyleninae	*Lithophane semibrunnea* (Haworth, 1809)
		Noctuidae	Xyleninae	*Mesapamea secalella* Remm, 1983
		Noctuidae	Xyleninae	*Mesapamea secalis* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Mesogona acetosellae* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Mesoligia furuncula* ([Denis & Schiff ermüller], 1775)
P/F		Noctuidae	Xyleninae	*Mormo maura* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Oligia latruncula* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Oligia strigilis* (Linnaeus, 1758)
P/F		Noctuidae	Xyleninae	*Orbona fragariae* (Vieweg, 1790)
		Noctuidae	Xyleninae	*Parastichtis suspecta* (Hübner, 1817)
	*	Noctuidae	Xyleninae	*Phlogophora meticulosa* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Pseudeustrotia candidula* ([Denis et Schiffermüller], 1775)
		Noctuidae	Xyleninae	*Rusina ferruginea* (Esper, 1785)
P/F		Noctuidae	Xyleninae	*Staurophora celsia* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Thalpophila matura* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Tiliacea aurago* (Denis & Schiffermüller, 1775)
F		Noctuidae	Xyleninae	*Tiliacea citrago* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Trachea atriplicis* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Xanthia gilvago* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Xanthia icteritia* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Xanthia ocellaris* (Borkhausen, 1792)
		Noctuidae	Xyleninae	*Xanthia togata* (Esper, 1788)
F		Noctuidae	Xyleninae	*Xylena exsoleta* (Linnaeus, 1758)